BELLCOMM, INC.

SUBJECT: Prelaunch Egress Procedures - Case 330 and [illegible]

DATE: August 31, 1966

FROM: P. R. Knaff
L. G. Miller

Abstract

This memorandum describes an exercise in which astronauts and pad rescue personnel practiced egress procedures on the Block I CM mock-up at NAA. The results of this three-day exercise of aided and unaided egress methods are reported, along with comments intended to give some perspective on the problems of egress. Lack of an accurate CM mock-up continues to hinder a valid assessment of prelaunch egress procedures.

Due to difficulties encountered by the flight crew during egress operations and the questionable reliability of certain mechanical equipment at the launch complex, the general crew consensus indicated a preference for on-pad EES abort in the event of a real emergency. The decision is by no means clear-cut, however, and the need to identify emergency situations that might arise is indicated.

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MAY 1977
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NASA STI FACILITY
INPUT BRANCH

FACILITY FORM 602
X66 37730
(ACCESSION NUMBER)
13
(PAGES)
CR-153525
(NASA CR OR TMX OR AD NUMBER)
1A
(CODE)
06
(CATEGORY)

(NASA-CR-153525) PRELAUNCH EGRESS PROCEDURES (Bellcomm, Inc.) 8 p

N79-72219

Unclas
00/16 12359

SUBJECT: Prelaunch Egress Procedures - Case 330 and Case 320

DATE: August 31, 1966

FROM: P. R. Knaff
L. G. Miller

MEMORANDUM FOR FILE

This memorandum describes the most recent practice of egress procedures on the Block I CM mock-up at NAA, Downey and attempts to give some perspective on that exercise. Efforts have been proceeding since the fall of 1965, for a valid demonstration of the ability to perform both aided and unaided egress from the Block I Apollo Command Module. Reference 1 gives a comprehensive picture of the status of these efforts as of January, 1966. Reports of recent developments will be found in References 2, 3, and 4. Reference 5 reports an earlier NAA test.

Prior to the conduct of this latest series of demonstrations, the following discrepancies existed on the Block I CM mock-up at NAA, Downey:

1. The sealing rings around the inner hatch were not in place.

2. The ECS suit hoses were not installed.

3. Suit electrical umbilicals were not installed.

4. The strap hinges on the boost protective cover hatch were not in place.

5. The many items to be stored in the CM, which might interfere with egress, were not represented.

While these deviations are significant, they did not prevent the development of aided egress procedures. They did, however, detract from the realism of the exercise and leave a number of unresolved questions.

Conduct of Demonstration

On July 26 and 27, activities were devoted toward the development of procedures for removing incapacitated astronauts from the Command Module. The pad rescue team was composed of members of the Emergency Egress Working Group who

[redacted]

are involved in the actual operations at KSC. On July 26, unaided egress runs were made by astronauts, including the members of the AS-205 prime crew.

Aided Egress (Incapacitated)

Two dummies dressed in Mercury space suits were used to simulate incapacitated astronauts during the first phase (i.e., aided egress) of the exercise. The third couch was occupied by an observer at times. Two members of the three-man rescue team were dressed in proximity suits (an aluminized cloth ensemble which affords a degree of protection from fires). Over the two-day period, approximately eight runs took place. Still and motion-picture records of some of these runs were obtained. When these become available, copies will be obtained for OMSF viewing.

During an egress run, two members of the team performed the major work with the third member assisting from the side. The operations were as follows:

1. Remove boost protective cover hatch and set aside.

2. Remove outer (ablative) hatch and set aside.

3. Remove inner (pressure) hatch and set aside.

4. One man enters CM, safes necessary switches, and removes harness restraints from center astronaut. Second man implaces board to be used in removal of center astronaut.

5. Second man passes hook to first man who attaches it to center astronaut's suit.

6. Second man pulls astronaut over the board while first man assists from inside CM.

7. Third member of team takes astronaut across egress arm (simulated) while first man removes restraint harnesses from second astronaut.

8. Process repeated for removal of second astronaut.

The results of this aided egress with incapacitated astronauts are given in Table 1. Table 1 also includes a breakdown of some of these times into significant operational steps which were actually performed. Several observations may be made about these data. In the first place, some of the numbers in

[illegible] the [illegible] [illegible] [illegible]

5. The lanyard handle attached to the release lanyard of the outer hatch latch drive did not operate easily. In addition some problem with assurance confirmation of successful hatch latch operation may occur during conditions of high stress.

4. The inner hatch, because of configuration and weight problems (approximately 90 lbs. in the scientific air-lock configuration) does not stow readily or easily. It cannot be passed to the side and it must be placed in a position which interferes with easy crew exit. It may be noted that the CM mock-up used for this demonstration was not as packed with equipment as the flight article will be. The problems encountered here are, therefore, milder than one might expect should a real egress be required.

5. When the scientific air-lock hatch was finally set down, it was deposited precipitously on a wire-bundle that runs on the CM bulkhead located behind the head of the center couch. Whether or not the impact would have been great enough to sever or short the wires in that bundle is problematical. If that configuration is valid for the flight article, the wire-bundle should be given additional protection against impact.

6. The combination of the outer hatch and BPO did not open easily and had to be kicked with great force several times before it would open. The force required for such kicks might be enough to deform the hatches and/or their latching, sealing, and operating mechanisms. This might result in a significant recycling delay.

Discussion

In spite of their shortcomings, the demonstrations precipitated a number of very useful results. They enabled rescue-team personnel to gain some idea of the procedures that would be necessary in performing an aided egress of incapacitated astronauts. More importantly, however, they established the necessity of rescue training. This was graphically illustrated by the reduction in elapsed time to remove the astronauts from four and a half to slightly less than three minutes.

The unaided egress demonstrations from the Block I vehicle were clearly of value. Besides acquainting the crew with the problems they would encounter in an emergency egress [illegible] for training [illegible]

and associated hardware to include a) a vehicle that will allow non-destructive egress in both nominal and emergency modes and b) a simulator that will allow the crew to practice smooth and rapid egress in a non-destructive fashion.

After the runs were completed, a debriefing was held with the crews in which it was made apparent that some basis for accurate simulation (like a mock-up) would have to be provided to develop operational proficiency by the crew for egress. A description of access arm problems was given by S. T. Beddingfield, MSO/MD-4, in which he enumerated some of the significant single-point failures which could occur. The accurate and concise description of these failures gave rise to the observation that, because of the access arm unreliability, the crew should delay egress initiation until after it is established that the access arm is attached and locked to the CM. The general difficulties found both with egress operations and with anticipated access arm performance led to the general crew consensus that, if a real emergency occurred on the pad, the LES mode would almost invariably be used. It was also noted that a situation could exist where activation of the LES could serve to precipitate a pad catastrophe. Presumably, the existence of such a situation might delay or force a reconsideration of the LES mode of exit. This of course reinforces the need to identify and describe in detail the emergencies which might be expected on the pad.

P. R. Hamer

L. G. Miller

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Attached:
Table 1
References

Copy to
Messrs. P. B. Benjamin - MASA/MM
C. H. Bolender - MASA/MOA
J. L. Cooper - MASA/MSO
J. K. Holcomb - MASA/MAO
P. A. Keegan - MASA/MA-2
J. Kubat - MASA/MAP
P. J. McElmurry - MASA/MOC
M. M. Ragsdale - MASA/MAR
P. E. Stuhr - MASA/MA-0

H. E. Domen - MSO/MD
J. O. Mobbton - MSO/ED

Copy to
Messrs.

J. W. Bilodeau - MSC/CF2
M. E. Cadenhead - MSC/PS6
W. J. North - MSC/CF
R. S. Sayers - MSC/CF24

C. Bidgood
D. R. Hagner
J. A. Hornbeck
B. T. Howard
J. Z. Menard
T. L. Powers
M. K. Purdy
H. M. Ross
T. H. Thompson
G. B. Troussoff
R. L. Wagner
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TABLE I - EMERGENCY RESCUE TESTS - CREW INCAPACITATED

OPERATION	TIME FROM START - SECS.							
	JULY 26, 1960					JULY 27, 1960 (1)		
	1:30 PM	3:50 PM	3:50 PM	3:55 PM	4:00 PM	9:50 AM	11:30 AM	11:30 AM
S[illegible] IN ENG HATCH, ACTUATE LATCHES, R[illegible] HATCH TO ACCESS ARE[illegible]	26				33	23	25	27
IN[illegible] HATCH IN ACE HATCH, ACTUATE LATCHES, R[illegible] HATCH TO PLATFORM	33				53	47	47	50
IN[illegible] HATCH IN PRESS HATCH, REMOVE AND STOW IN[illegible] BELOW OPENING ON Z-Z STRUTS	73			10 (5)				
IN[illegible] HATCH IN PRESS HATCH, REMOVE TO OUTSIDE BY[illegible] HATCH AND LETTING HIM CLIMB		22	14.8 (5)		78	60	60	67
IN[illegible] MAN INTO CM, DROP CENTER HEAD REST, R[illegible], RELEASE RESTRAINT FITTING. IN[illegible] BOARD (2ND MAN)					95			
IN[illegible] [illegible] (ATTACHED TO PULL CORD) IN[illegible] BETTIS CHEST STRAP					120	130	120	103
R[illegible] CENTER MAN TO ACCESS ARE					145	150 (3)	140	127
[illegible] 2ND TEST	161				200 (2)			(4)
RE[illegible] 2ND MAN TO ACCESS ARE	271				287		197	176

TEST CREW OF:

FIRST TESTS: 1. WM ELDREDGE, WALNUT CORP.

2. MORRIS C. GRAY NASA/SPD-22

SECOND TESTS IN PROXIMITY SUITS
/ [illegible] TESTS

(1) TIMING STARTED WITH RESCUERS AT FOOT OF MOCK-UP STEPS.

(2) L.E. EQUIP. CONTROLLER ARM REST STUCK. LOST EST. 30-45 SECS. - LEFT POST IN, PULLED DUMMY PAST IT. POST LATER RELEASED.

(3) L.E. SHOULD RESTRAINT (D RING) STUCK. TEST STOPPED. THIS RESTRAINT LEFT OUT FOR BALANCE OF TESTS.

(4) L.E. ARM REST LEFT IN PLACE DURING TEST. EST. SAVES 10 SECS. ELDREDGE BELIEVES A LIGHT BODY WOULD REQUIRE ITS REMOVAL EVEN LESS THAN A DUMMY.

(5) TESTS SHOW REMOVAL TO OUTSIDE IS PREFERABLE - IT CLEARS CM FOR RETRY OF ONE RESCUEE.

REFERENCES

1. "Provisions for On-Pad Emergency Egress from CM: Current Status - Case 330," Memorandum for File, dated January 4, 1966, by P. R. Knaff and L. G. Miller.

2. "Trip Report - Attendance at Apollo Emergency Egress Working Group Meeting, July 13, 1966 - Case 330," Memorandum for File, dated July 20, 1966, by L. G. Miller.

3. "Trip Report - Attendance at LC-37B Review, July 14-15, 1966 - Case 330," Memorandum for File, dated July 20, 1966, by L. G. Miller.

4. "Apollo Engineering Quick-Look Test Report" entitled "Evaluation of Main Access Hatch Emergency Egress during Prelaunch Period (Block II)," ATR No. 402106, dated 9/16/65, prepared by W. R. Boehlke.

5. "Crew Simulation Unit" entitled "Evaluation of Main Access Hatch Entry and Emergency Egress During Prelaunch Period," dated November 22, 1965, prepared by C. Kuplent of NAA.